Part 1. Report Cover

Report Number: DLAF045 **Report Date:** 6 May 02

Previous Report Number: 00AYP032 **Report Date:** 21 Aug 00

Title: Performance Oriented Packaging Testing of a Grade V3c, Fiberboard Box, Style RSC, 12" x 12" x 12" (ID), with Padded 1-Quart, Friction Plug (Lid), Round, Metal Cans (Qty of 4) for Liquids

Responsible Individual: Francis S. Flynn

Performing Activity: LOGSA Packaging, Storage, and Containerization Center
ATTN: AMXLS-AT
11 Hap Arnold Boulevard
Tobyhanna, PA 18466-5097

Performing Activity's Reference(s): TT 10-02; 9HTNR; AMC 13-88

DTIC Distribution: N/A

Requesting Organization:
Defense Logistics Agency
Defense Distribution Center
ATTN DDC J-3/J-4-0
2001 Mission Drive
New Cumberland PA 17070-5000

Requesting Organization's Reference(s):
DLA Memo, 12 Dec 01

Test Results: ___ single _X_ combination ___ composite

Section I. Pre-test Conditions

For initial testing, one box was received in new condition, from the DDTP post box fabrication shop.

The following identification schema designates the packaging specimen used for the test(s) indicated.

Specimen No.	Test
A	stack test
A	repetitive-shock vibration test
A	flat onto bottom, drop test
	flat onto long side, drop test
	flat onto top, drop test
	flat onto short side, drop test
	bottom corner, drop test
B	water resistance test

Section II. Summary

A. Drop test	**PASS**
B. Leakproofness test	N/A
C. Internal pressure test/Hydrostatic pressure test	N/A
D. Stacking test	**PASS**
E. Vibration standard	**PASS**
F. Water resistance test	**PASS**
G. Compatibility test	N/A

Note: To be certifiable, the configuration must pass the applicable tests for the type packaging, intended lading, and mode(s) of shipment. This report is applicable to all surface modes.

Test Results (continued)

Section III. Discussion

A. Drop test: *49 CFR §178.603* **Test date(s):** 4/16/02

___ cold conditioned (0° F, 72 hr)
_X_ ambient conditions (~72° F)
___ standard conditions (50% RH & 23° C)

No.	Ht.	Orientation	Results
A	71 "	Flat onto box bottom (3)	Pass/No leaks/rupture; entire contents retained
A	71 "	Flat onto box long side (4)	Pass/No leaks/rupture; entire contents retained
A	71 "	Flat onto box top (1)	Pass/No leaks/rupture; entire contents retained
A	71 "	Flat onto box short side (6)	Pass/No leaks/rupture; entire contents retained
A	71 "	Diagonally onto bottom joint corner (5-2-3)	Pass/No leaks/rupture; minor crushing of the 5-2-3 corner; contents retained completely within the box

Specimen A, a combination packaging (four 1-quart, padded, friction plug metal cans, in a grade V3c fiberboard box), was dropped from 71 inches onto the required four flat sides and the bottom manufacturer's joint corner. There was no noted leakage from or rupture of the cans. Upon examining the box, there was no leakage, rupture, or damage noted, except for minor crushing of the 5-2-3 corner. The cans were retained completely within the box. The vermiculite had settled, approximately 1 inch.

In conducting the drop test, all five drops (flat bottom, flat long side, flat top, flat short side, and bottom corner) were performed on the same configuration. The decision to use the same container (configuration) for all five drop orientations was based on the relatively minimal damage demonstrated during previous testing of grade V3c, fiberboard boxes with different inner containers or articles. Five drops per configuration exceeds *49 CFR §178.603* requirements, as well as both UN and ASTM recommendations (i.e., one drop on a side or corner per box). The use of one configuration for multiple tests and drops is DOD policy as stated in DLAD 4145.41/AR 700-143/AFJI 24-201/NAVSUPINST 4030.55A/MCO 4030.40A, Packaging of Hazardous Material. Also per this policy, any failed orientation(s) can be repeated using another configuration.

B. Leakproofness test: *49 CFR §178.604*
N/A. The leakproofness test was not conducted on the box, because the packaging is not intended for the containment of liquids.

C. Internal Pressure/Hydrostatic Pressure test: *49 CFR §178.605*
N/A. Testing for the maintenance of internal pressure is not required for this configuration.

Test Results: Section III (continued)

D. Stacking test: *49 CFR §178.606* **Test date(s):** 3/19/02

___ standard conditions (23° C & 50% RH)
_X_ ambient conditions (~72° F)
___ high temperature conditions (104° F)

No.	Length	Type	Load/Force Required	Peak Force	Results	Stability Maintained?
A	24 hr	Static	366 lb	N/A lbf	Pass	Yes

A static top load (500 lbs) was used for the stack test, because it could hold the load constant for the required 24-hour timeframe. The total top load applied on the empty box was greater than the minimum required for one box based on the outside box height and the gross packaged weight. The top load was to simulate a stack of identical packagings that might be stacked on the packaging during transport.

E. Vibration test: *See 49 CFR §178.608.* **Test date(s):** 4/15/02

No.	Frequency	Duration	Results
A	3.05 Hz	1 hr	Pass. No leakage, rupture, or damage

To be in compliance with U.S. Department of Transportation standards for packagings bearing the United States mark (USA) as a component of the packaging certification marking (*49 CFR §173.24a(a)(5)*), the vibration test was performed, as a means to determine capability. The test was conducted as prescribed by ASTM D 999, method A2 (Repetitive Shock Test (Rotary Motion)). The test was run for 1 hour, using the fiberboard box packaging. The packaging was tested using a 1,250-lb vibration table (rotary motion) that had a 1-inch vertical double amplitude (peak-to-peak displacement) such that the packaging was raised from the platform to such a degree that a piece of steel strapping (1.6 mm) could be passed between the bottom of the package and the platform.

F. Water resistance (Cobb Method) test (fiberboard): *49 CFR §178.516*
As required by the standards for fiberboard boxes, the Cobb Method Test for water absorptiveness was performed on a specimen cut from one box (specimen 3) taken from the same bundle as the box used for rough handling (drop, stack, and vibration) testing.

Test date(s): 4/3/02

No. specimens felt side (exterior) 5. Average 115 g/m². Highest exterior value was 124 g/m². Lowest exterior value was 111 g/m². All of the samples tested were free of printing.

No. specimens wire side (interior) 5. Average 117 g/m². Highest interior value was 120 g/m². Lowest interior value was 114 g/m².

No. specimens exceeding 155 g/m² 0.

Test Results: Section III (continued)

It should be noted that improper storage and rough handling could break the fibers and abrade the coating of the box, decreasing its ability to resist water absorption. This could result in higher test values. Since commercial boxes are occasionally made with the wire facing (interior) as the exterior side of the box, specimens from both the wire (interior) and the felt (exterior) facings should be tested for water absorptiveness.

G. Compatibility test (plastics packagings only): N/A.

Test Personnel

The following personnel performed the aforementioned testing, or had a role in the testing, evaluation, and/or documentation, as reported herein-- Richard D. LaFave, Charles A. Burd, Bruce W. Samson, Timothy L. Reimann, and Karen K. Kimsey

References

A. Title 49 Code of Federal Regulations, Parts 106-180, Winter 2002, current as of 15 Oct 02

B. International Air Transport Association Dangerous Goods Regulations, 40th edition, 1 January 1999

C. ASTM D 4919, Specification for Testing of Hazardous Materials Packagings.

D. ASTM D 999, Standard Method for Vibration Testing of Shipping Containers.

E. ASTM D 951, Standard Test Method Water Resistance of Shipping Containers by Spray Method.

F. TAPPI Standard: T 441 Water Absorptiveness of Sized (Non-Bibulous) Paper and Paperboard (Cobb Test).

G. Recommendations on the Transport of Dangerous Goods, sixth revised edition, United Nations, New York, 1990.

H. DLAD 4145.41/AR 700-143/AFJI 24-201/NAVSUPINST 4030.55A/ MCO 4030.40A, Packaging of Hazardous Material, 23 Jul 96

I. AFJMAN 24-204/TM 38-250/NAVSUP PUB 505/MCO P4030.19G/DLAI4145.3, Preparing Hazardous Materials for Military Air Shipments, 1 Mar 97

Test Results: Section III (continued)

Equipment

Item	Manufacturer	Serial No.	Calibration Expiration Date
1,250-lb vibration table	L.A.B Skaneateles, NY	8120179	*see note*
5,000-lb compression tester	L.A.B Skaneateles, NY	1107050	4/03
drop tester	Lansmont	M12006	N/R
Cobb Sizing Tester	Teledyne Curley Troy, NY	4180-A	N/R

Note. Equipment is calibrated in accordance with International Safe Transit Association test equipment verification requirements.

Appendix A

Test Applicability

Pass/fail conclusions were based on the particular fiberboard box specimens, test loads, and the limited quantities submitted for test. Extrapolation to other materials, other manufacturers, other applications, different inner packagings, container sizes, or lesser inner quantities is the responsibility of the packaging design agency or applicable higher headquarters. Extrapolation of test results based on less than the minimum recommended number of test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

Testing was performed per *Title 49* Code of Federal Regulations.

Performance testing was undertaken and completed at the request of an agency responsible for shipment of the dangerous good(s). The completion of successful required performance tests does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).

The required performance tests are intended to evaluate the performance of the packaging components. The criteria used to evaluate packaging performance is whether the contents of the packaging are retained within the outer packaging, should damage to the outer packaging occur, and secondly, if any inner packaging of hazardous materials leaks, ruptures, or is damaged so as to affect transportation safety. The successful completion of the required tests does not ensure the undamaged delivery or survivability of the actual commodity/item. Separate testing is necessary to assure the stability of any explosive item.

Before a configuration can be certified by the person(s) authorizing shipment, the appropriate packaging for the particular hazardous materials and mode of transportation must be determined, and the item(s) must be prepared for shipment per applicable regulations. The chosen configuration must have been performance tested in accordance with the size, the shape, and the weight constraints posed by the configuration to be certified. The testing reported herein should not be construed as blanket certification of any configuration that simply uses the performance tested outer fiberboard box. Packaging paragraphs apply.

Appendix B

Test Data Sheet

Section I. Test Product

Physical State: ___ solid _X_ liquid ___ gas ___ aerosol

Name: Water

Amount Per Container (Configuration):
1 quart (4 qt), rated; 2.08 lb (8.32 lb); 2.34 lb (9.36 lb), packed

Gross Weight: 22.1 lb

Section II. Test Parameters

Drop Height: Ref: *49 CFR §178.603*

_X_ **1.8 m; 71 in.** (PG I, II, & III, SG ≤1.2 or solids)
___ 1.2 m; 47 in. (PG II & III, SG ≤1.2 or solids)
___ 0.8 m; 32 in. (PG III, SG ≤1.2 or solids)
___ from-- ___ PG I: SG x 1.5 m x 59.06 in./m
___ PG II: SG x 1.0 m x 39.37 in./m
___ PG III: SG x 0.67 m x 26.38 in./m

Stacking Weight Formula, Liquids – DLA

Variables		Inputs		
h	height, drum/box	12.5		
n	# stacked containers	XXXXXXXX	9.44	
w1	weight, drum/box	2		
w2	weight, bottle/can	0.26		
w3	weight, ring/pad	0		
q1	# inner containers	4		
v1	max. volume, 1 inner container	1		
v	total volume	XXXXXXXX	1	
w4	weight, item (unpacked)	8.3		
W5	weight, absorbent	8		
W	total weight	XXXXXXXX	21.36	
C	constant	1		
A1	Stacking weight-PG I	XXXXXXXX	**262.7**	**263**
A2	Stacking weight-PG II	XXXXXXXX	**303.9**	**304**
A3	Stacking weight-PG III	XXXXXXXX	**365.6**	**366**

NOTE: A1 = (n-1)*(w+(1.2*v*8.3*0.98))*(c), Packing Group I
A2 = (n-1)*(w+(1.8*v*8.3*0.98))*(c), Packing Group II
A3 = (n-1)*(w+(2.7*v*8.3*0.98))*(c), Packing Group III

A1 = stacking weight in pounds, PG I
A2 = stacking weight in pounds, PG II
A3 = stacking weight in pounds, PG III
n = (118/h), minimum number of containers that when stacked, reach a height of 3 m
w = w1+(w2*q1)*(w3*q1)*w5, total weight in pounds
v = v1*q1, total volume
c = either 1.5 (the compensation factor that converts the static load of the stacking test into a load suitable for dynamic compression testing), or 1.0 (static top load)

Appendix B (Continued)

Section III. Equivalencies of Liquids

	Specific Gravity[1]	Total (Each) Amount per Container	Gross Weight (pounds)	(kilograms)
water*	1.0	8.32 lb	21.36	9.69
PG I	1.2	9.98 lb	23.52	10.67
PG II	1.8	14.97 lb	24.76	11.23
PG III	2.7	22.46 lb	26.64	12.08

Note 1. Equivalent specific gravity derived from drop height as follows-- PG factor x density (or SG) = drop height, thus SG = drop height/PG factor (49 CFR §178.603)

PG I: 1.5 m x SG = 1.8 m, thus SG = 1.2
PG II: 1.0 m x SG = 1.8 m, thus SG = 1.8
PG III: 0.67 m x SG = 1.8 m, thus SG = 2.7

Unless otherwise computed for more dense liquids, water (SG = 1) represents a solution having a specific gravity of 1.2 or less.

Appendix C

Packaging Data Sheet

Section I. Exterior Shipping Container

Packaging Category: ___ single _X_ combination ___ composite

UN Type: Fiberboard boxes (*49 CFR §178.516*) UN Code: 4G

Specification No.: PPP-B-636; Style RSC; 1.9 lbs.;
12" x 12" x 12" (ID); 12½" x 12½" x 12½" (OD)

Manufacturer: Packaging Control Corp., York, PA 17402

Date(s) of Manufacture: February 2001

Closure Method: The fiberboard box was sealed (7 strip method) using 2" A-A-1830 clear tape. (See drawing)

Additional Description:

a. A 4-Mil-poly bag was first placed in the fiberboard box for the purpose of encapsulating the absorbent and the test product. Approximately 2.5 inches of firmly packed, loose-fill absorbent cushioning was placed in the bottom of the fiberboard box. Four, 1-quart padded paint cans were placed on the absorbent and more loose fill absorbent material was then firmly packed around and over the foam padded cans. Approximately 1¾ inches of absorbent material separated the cans from the sides and ends of the box. The loose fill absorbent material must be firmly packed into the box corners, and must completely fill the box. Void space is not acceptable.

b. For this configuration, either firmly packed, fine grade vermiculite or either of the following, firmly-packed cellulose fiber absorbent products, "HAZMATPAC® Absorbent A-900" or "Absorption Corporation Absorbent GP", can be used without any notable difference in performance. Inner packagings have a tendency to migrate if the loose fill material is not firmly packed, especially along the bottom of the container.

c. The quantities of absorbent material do meet the guidelines for absorbent materials as outlined in AFJMAN 24-204/TM 38-250/NAVSUP PUB 505/MCO P4030.19F/DLAM 4145.3, Preparing Hazardous Materials for Military Air Shipments.

Bag Manufacturer: Quality Packaging Systems of Warren, Inc.,
24260-2 Mound Road, Warren, MI 48091-5324

Absorbent Manufacturer: HAZMAT PAC A-900

Appendix C (Continued)

Section II. Inner Packaging/Article

Quantity of Inner Containers: 4 Capacity: 1 quart each

Specification Type and No(s).: N/A

Type/Materials: 1-quart triplette paint can, friction plug (lid)

Manufacturer/Distributor: Freund Can Company
Chicago, IL 60620

Manufacturer/Distributor Part Number(s): can-- 1818A
bail-- N/A
lid-- 6618A

Tare Weight (empty): 0.269 lb Filled Weight: 2.34 lb

Dimensions: 4⅛ in. - diameter (OD)
4⅞ in. - height (OD)

Closure Type: Friction plug

Secondary Closure: N/A

Appendix D

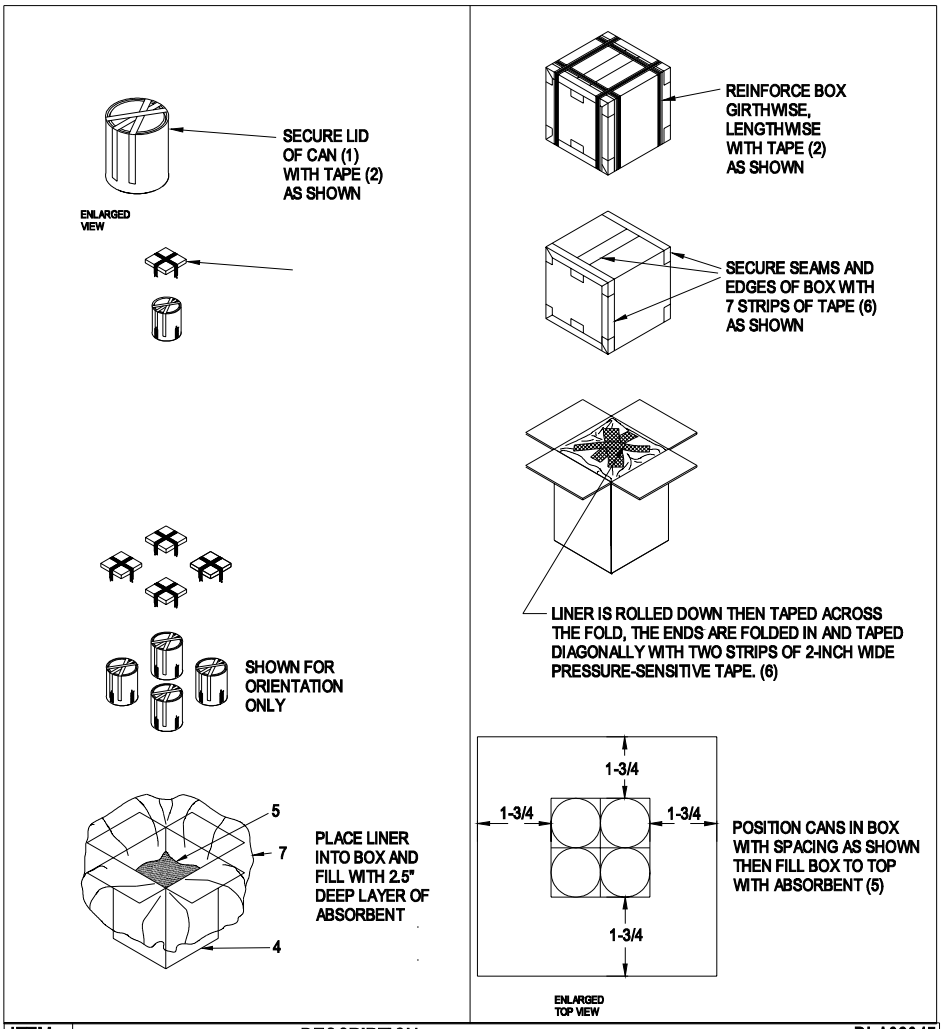
Rationale

The equivalent of Packing Group I (great danger) testing was requested for a 12- by 12- by 12-inch corrugated fiberboard box having as the intended contents four 1-quart, friction plug (lid), round, metal cans. The can is more commonly known as a paint can. The configuration to be tested is intended to be applicable to a large assortment of liquid products contained in round, friction plug (paint), metal cans.

For testing, substitution for the actual hazardous lading is permitted by *49 CFR §178.602(c)*. Water can be used as a substitute liquid.

One combination packaging made to the above described configuration was subjected to drop and vibration testing as prescribed in ASTM D 4919. These tests are designed to simulate the shock and vibration a package (configuration) may encounter when being shipped worldwide by truck, rail, or ocean going transport. The order of testing was vibration, then drop testing. Prior to the rough handling testing of the packed box, static loading was performed on an empty box. This is a U.S. DOT approved method of stack testing, especially when the combination packaging has wide applications. A separate box was used for water absorptiveness testing of the fiberboard.

Appendix D (Continued)
Drawing



ITEM	DESCRIPTION DLA02045
1	1-QT., METAL, ROUND, FRICTION LID, QTY. 4
2	1-INCH WIDE, PRESSURE-SENSITIVE TAPE, FILAMENT-REINFORCED, IAW ASTM D5330, TY II
3	FOAM PAD, POLYETHYLENE, 1 X 4-1/4 X4-1/4 IN., QTY.4
4	FIBERBOARD BOX, ASTM D5118, STYLE RSC, GRADE V3c, NSN: 8115-00-183-9491, 12X12X12 IN.
5	CELLULOSE FIBER ABSORBENT, OR VERMICULITE, A-A-52450
6	2-INCH WIDE, PRESSURE-SENSITIVE TAPE, IAW ASTM D 5486, TY II, NSN: 7510-00-266-6715
7	4 MIL POLYETHYLENE LINER 18 X 30 INCHES

Appendix D (Continued)

Appendix D (Continued)